OPAL-RT

OP4510 RT-LAB-RCP/HIL SYSTEMS
User Guide

www.opal-rt.com

Published by

OPAL-RT Technologies, Inc. 1751 Richardson, suite 2525 Montreal, Quebec, Canada H3K 1G6

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Printed in Canada

SYMBOL DEFINITIONS

The following table lists the symbols used in this document to denote certain conditions:

Symbol	Definition
	ATTENTION: Identifies information that requires special consideration
	TIP: Identifies advice or hints for the user, often in terms of performing a task
	REFERENCE _ INTERNAL: Identifies an additional source of information within the bookset.
CAUTION	Indicates a situation which, if not avoided, may result in equipment or work (data) on the system being damaged or lost, or may result in the inability to properly operate the process.
	Indicates a situation where users must observe precautions for handling electrostatic sensitive devices.
	CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.
	WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.

CONTENTS

INTRODUCTION **7**
RECEIVING AND VERIFICATION 8
Standard Hardware 8
SIMULATOR ARCHITECTURE 9
USER INTERFACE 10
Front 10
OP4510-1 Rear (standard configuration) 11
OP4510-2 Rear (optional fiber optic configuration) 11
CONNECTING CABLES **12**
Testing I/O Signals 12
DIN and DOUT Loopback Test *12*
AIN and AOUT Loopback Test *12*
GENERAL PIN ASSIGNMENTS **13**
SPECIFICATIONS **14**
I/O SPECIFICATIONS 15
32 Digital In (OP5353) 15
32 Digital Out (OP5360-2) 15
16 Analog In (OP5340) 16
16 Analog Out (OP5330) 16
RS422 Digital In 16
RS422 Digital Out 16
LIMITED WARRANTY **19**
Limited Warranty 19
Return Policy 19
Exclusions 19
Warranty Limitation and Exclusion 20
Disclaimer of Unstated Warranties 20
Limitation of Liability 20

INTRODUCTION

The OP4510 is a compact device with 128 fast I/O channels with signal conditioning, additional RS422 channels (or optional low-speed fiber optic channels), high-speed communication ports (SFPs), and is fully integrated with Simulink, SimPowerSystem. The integration of high-end INTEL multi-core processors with powerful Kintex 7 FPGA provides greater simulation power and sub-microsecond simulation time steps to maximize accuracy of fast power electronic systems. The OP4510 can simulate power grids with up to 200 nodes.

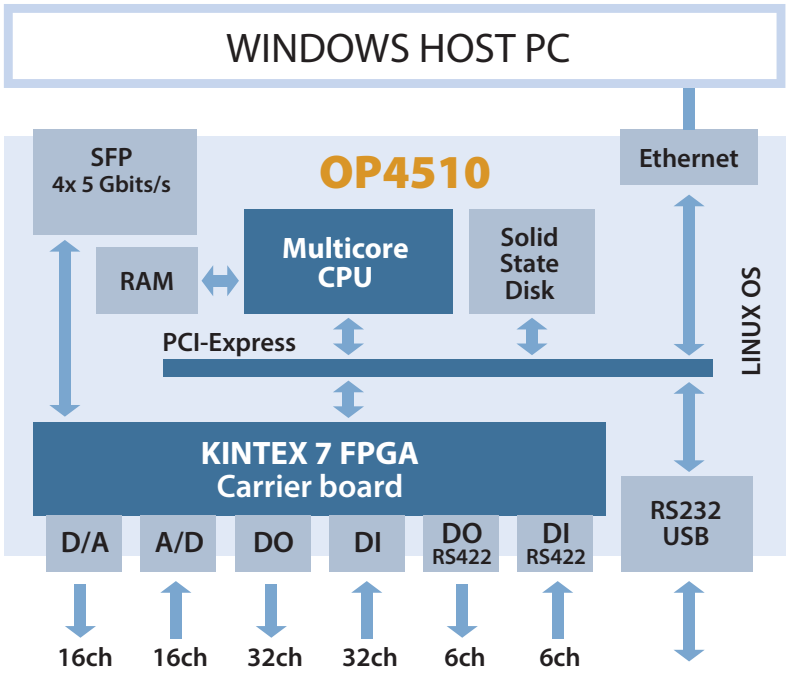


Figure 1: OP4510 system architecture (standard configuration)

A series of standardized I/O configurations are available with the OP4510, each targeting specific applications. The System Description document provides detailed, specific bitstream information for the application purchased by the customer.

RECEIVING AND VERIFICATION

After opening the package, remove the equipment and components. Make sure that all the items described in “Standard Hardware” are actually in the box and are undamaged.

Standard Hardware

The OP4510 real-time simulator includes the following basic hardware:

Item	Description	Part Number
OP4510 simulator		N/A
System Integration binder	RT-LAB software CD O/S CD (Redhat) Documentation CD Loopback board Loopback cable	C-02B-CAT6 126-0361 113-0737
RJ45 cable (1x)	CAT6 (500 MHz) UTP Network Cable - Blue 10FT	C-10B-CAT6
Power cable	1.83 m (6’) power cord, black (10A 125V)	CPC06

OPAL-RT strongly recommends the use of anti-static wrist straps whenever handling any electronic device provided by OPAL-RT. Damage resulting from electrostatic charges will not be convered by the manufacturers warranty.

Disconnect power before servicing

SIMULATOR ARCHITECTURE

The following image illustrates the simulator's architecture for each option using assembly views of the simulation hardware components within the OP4510 chassis. The OP4510 is an entry-level simulator that contains an FPGA carrier, which can accept four standard OPAL-RT mezzanine boards, in addition to the RS422 signals.

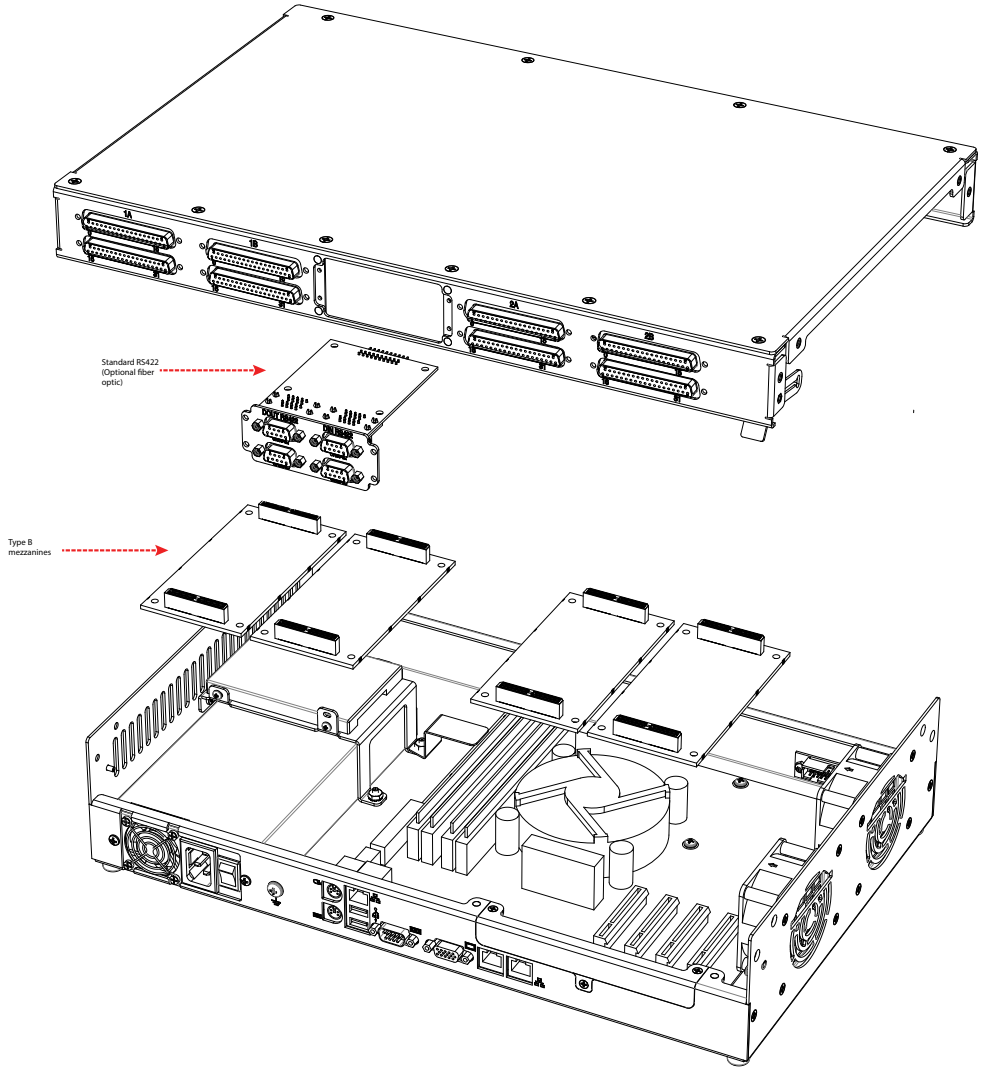


Figure 2: OP4510 Components (back view)

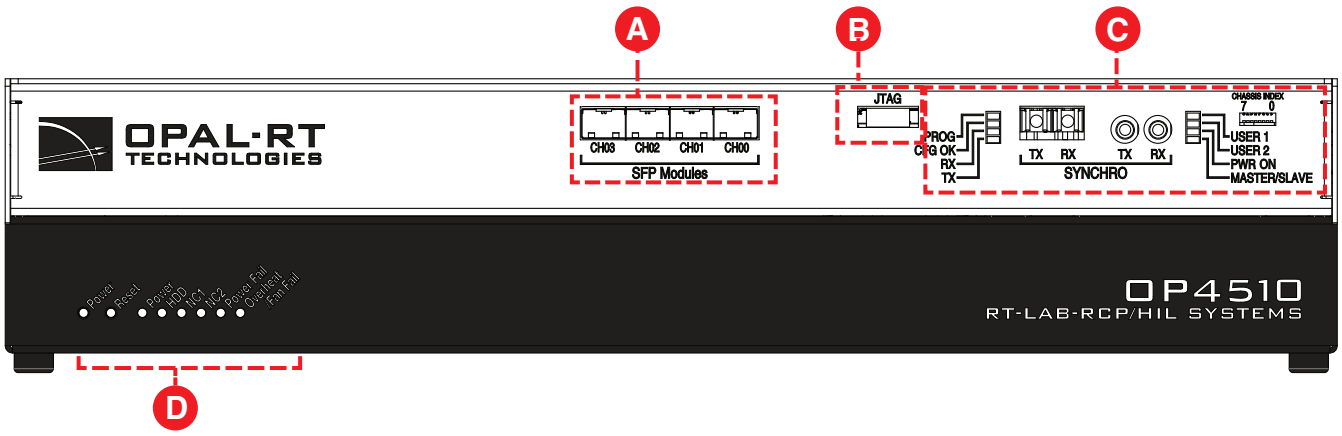
The OP4510 can contain any 4 type B mezzanine boards, according to user needs. the standard OP4510-1 contains 2 digital and 2 analog boards (see "I/O Specifications" for details). These mezzanine boards interface using a DB37 connector at the back of the chassis.

Four pairs of DB37F connectors provide up to 32 channels (Channel 00 to 15 and 16 to 31) and DB9 (RS422) connectors each provide an additional six channels.

The OP4510 offers two types of synchronization, either LVDS or fiber optic, making it easier to synchronize with any OPAL-RT device.

USER INTERFACE

Front



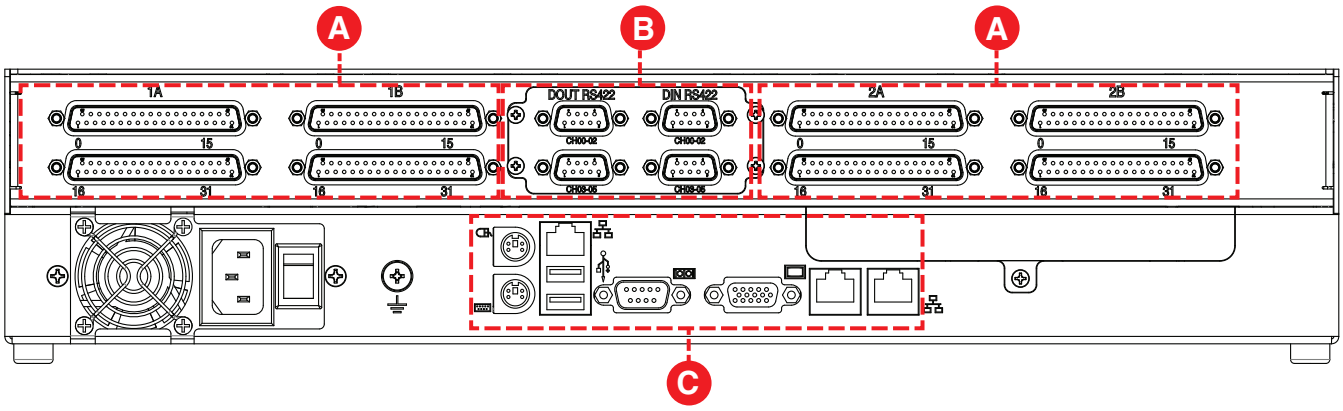
A. Small Form-factor pluggable (SFP) module connectors provide 4 high speed communication links between OPAL-RT FPGAs or between FPGA and user controllers. The SFP use Aurora communication protocol. Use of these ports requires a custom bitstream.
B. JTAG connector (for OPAL-RT technicians' use only).
C. Synchronization connectors status, and user configurable LEDs:

LED Label	Description
PROG/ CFG OK:	CFG OK steady on green and PROG off indicates the FPGA is functioning normally. CFG OK off and PROG steady on yellow indicates the the FPGA has stopped and is no longer functioning.
RX:	Green when receiving synchronization
TX :	Green when transmitting synchronization
USER 1:	Green LED controlled (configured by user using Simulink blocks)
USER 2:	Green LED controlled (configured by user using Simulink blocks)
PWR ON:	Green indicate OP4510 power is functioning
MASTER/SLAVE: .	Green indicates MASTER mode, Yellow indicates SLAVE mode. Flashing green and yellow indicates a SAFE bitstream in the FPGA
CHASSIS INDEX:	8-pin DIP switch that allows users to set the device's network chassis index. It can be set from 00 to FF (in HEX) for a maximum of 256 addresses.
SYNCHRO Label	**Description**
TX/RX	Fiber optic connector. Compatible with OP4500, OP5607, OP7000 and OP7020. Synchronizes time steps between systems and includes high speed FPGA pulses.
TX/RX	Stereo jack. Compatible with all OPAL-RT products.

D. Target computer monitoring interface. Two push buttons and 6 LED indicators:

Name	Interface	Status	Description
Power	Pushbutton		Power on or shut down the Target computer
Reset	Pushbutton		Resets the target computer
Power	LED	Green	On indicates that the unit is powered up.
HDD	LED	Green	On indicates that the hard disk drive is operating.
NIC1	LED	Green	On indicates that network port 1 is in use.
NIC2	LED	Green	On indicates that network port 2 is in use.
Power Fail	LED	Red	On indicates a power fault.
Overheat/Fan Fail		Red	On indicates either that unit has overheated or a fan fault.

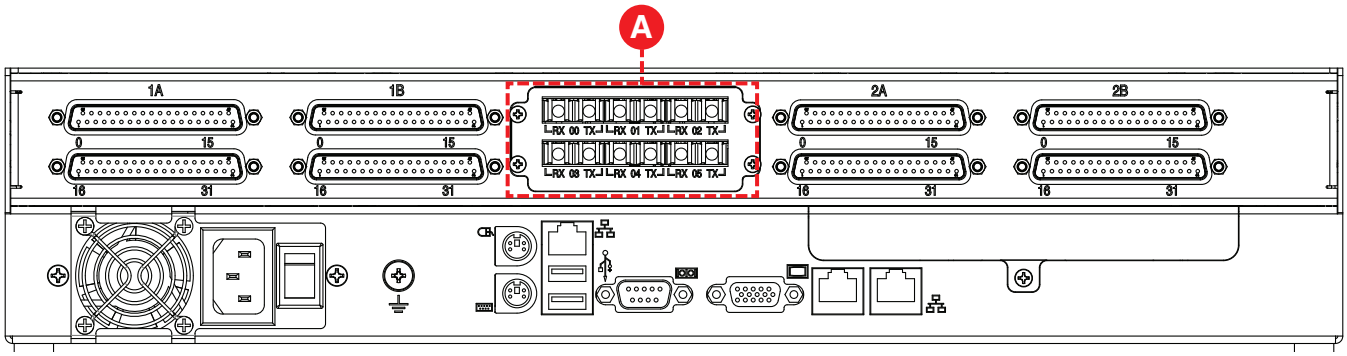
OP4510-1 Rear (standard configuration)



A. DB37 connectors for digital or analog inputs and outputs.
B. DB9 connector module for RS422 signals, typically used to transmit differential encoder inputs and outputs.
C. Standard computer connectors (left to right): mouse and keyboard, USB ports, monitor, network ports*.

*Note that only one network port (the leftmost connector)is required for network connection; use of other connectors is optional.

OP4510-2 Rear (optional fiber optic configuration)



A. Fiber optic connector module, providing 6RX and 6 TX channels.
Each RxTx pair use Avago AFBR-2624Z (RX) and AFBR-1624Z (TX)
These channels can be used as digital I/Os or for low-speed communication protocols. The ORION protocol, developped by OPAL-RT, is compatible with these channels and available in custom bitstreams.

CONNECTING CABLES

These are the basic cabling instructions for your OP4510. Use the cables provided to connect your devices, as instructed.

1. Connect power cord to unit and to appropriate power source (outlet).
2. Connect DB37 cables from OP4510 to external devices (motor, controller, etc.). Before connecting cables, make sure that amplitude are compatible with OPAL-RT DB37 amplitudes (see Specifications).
3. Connect DB9 cables (for RS422 signals) from OP4510 to external devices.

You are now ready to power up your OP4510. Make sure that all cables are properly connected before powering up.

Testing I/O Signals

Before using your OP4510, it is good practice to test signals using the loopback board provided with the integration kit and RT-LAB, which lets you read any feedback from outputs to inputs.

DIN and DOUT Loopback Test

1. Connect the loopback board to a Dout DB37 connector and connect the cable to a Din DB37 connector.
2. Connect the loopback board's Vuser to a power source
3. Observe the Dout feedback on the Din using the integration model provided.

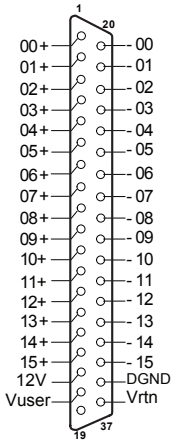
AIN and AOUT Loopback Test

1. Connect the loopback board to an Aout DB37 connector and connect the cable to a Ain DB37 connector.
2. Observe the Aout feedback on the Ain using the integration model provided.

GENERAL PIN ASSIGNMENTS

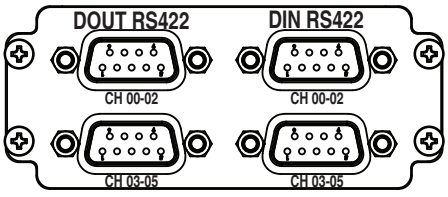
The following tables provide the generic pin assignments for the OP4510's DB37 and DB9 connectors. More detailed information, tailored to specific firmware, can be found in the Integration documents provided with your order.

DB37 pin	Channel pin assignment	DB37	Channel pin assignment
1	+00	20	-00
2	+01	21	-01
3	+02	22	-02
4	+03	23	-03
5	+04	24	-04
6	+05	25	-05
7	+06	26	-06
7	+07	27	-07
9	+08	28	-08
10	+09	29	-09
11	+10	30	-10
12	+11	31	-11
13	+12	32	-12
14	+13	33	-13
15	+14	34	-14
16	+15	35	-15
17	+12V*	36	DGND
18	Vuser	37	Vrtn
19			



* Non-isolated, limited to 400mA

DB9F Pin	RS422 OUT CH 00-02	DB9F Pin	RS422 IN CH00-02
1	TX0+	1	RX0+
2	TX1+	2	RX1+
3	TX2+	3	RX2+
4	N.C	4	N.C
5	+12V limited *	5	+12V limited *
6	TX0-	6	RX0-
7	TX1-	7	RX1-
8	TX2-	8	RX2-
9	DGND	9	DGND
DB9F Pin	**RS422 OUT CH 03-05**	**DB9F Pin**	**RS422 IN CH03-05**
1	TX3+	1	RX3+
2	TX4+	2	RX4+
3	TX5+	3	RX5+
4	N.C	4	N.C
5	+12V limited *	5	+12V limited *
6	TX3-	6	RX3-
7	TX4-	7	RX4-
8	TX5-	8	RX5-
9	DGND	9	DGND



*Same 12V for all the connectors. 400mA total

SPECIFICATIONS

Product name	**OP4510 RT-LAB-RCP/HIL SYSTEM** OP4510-1, Standard RS422 OP4510-2, optional fiber optic	
FPGA	Kintex-7 FPGA, 325T, 326,000 logic cells, 840 DSP slice (Multiplier- adder)	
Computer	8GB RAM. Xeon E3 4 core CPU, 3.2 GHz, solid state hard disk 128 GB	
I/O connectors	**OP4510-1 (standard)** DB37F DB9 (RS422, 25 MHz)	**OP4510-2 (optional)** DB37 Avago fiber optic (50 MBaud)
I/O module mezzanines	4	
High speed communication port	4 SFP, 1 to 5 Gbits/s optical cable pairs (Rx/Tx)	
PC interface	Standard PC connectors (monitor, keyboard, mouse and network)	
Power supply voltage range	90-132 or 185-260V, (115/230 auto)	
Frequency	50/60 Hz	
Dimensions (WxDxH)	43.2 x 27.4 x 8.9cm (17” x 10.8” x 3.5”)	
Weight	Approx. 5 Kg (11 lbs)	
Operating temperature	10 to 40 ºC (50 to 104ºF)	
Storage temperature	-55 to 85ºC (-67 to 185ºF)	
Relative humidity	10 to 90% non-condensing	
Maximum altitude	2000 m (6562 ft.)	

I/O SPECIFICATIONS

The OP4510 can hold any combination of four of the following Type B mezzanines. The standard OP4510-1 contains one of each.

32 Digital In (OP5353)

Number of channels	32 digital inputs
Isolation	Optical isolator
Connection mode	Anode and cathode available on connector
Input current	3.6 mA, current limiting diode
Reverse voltage protection	Schottky diode
Maximum reverse voltage protection	30 Volts
Detection threshold	Separate Schmitt Trigger
Voltage range	4 to 50 Vdc

32 Digital Out (OP5360-2)

Number of channels	32 digital outputs 2 banks of 16, fully isolated and independant of each other
Isolation	Galvanic isolator
Output Protection	50 mA resettable fuse
Protection thresholds	Over voltage: 30.1V Reverse voltage: maximum 30 V.
Output Voltage range	5 to 30 Vdc max
Output configuration	Push-pull, tri-state output

16 Analog In (OP5340)

Number of channels:	16 differential
Resolution:	16 bits
Input range (V)	±20v to ±120v

16 Analog Out (OP5330)

Number of channels:	16 single-ended
Resolution:	16 bits
Default range:	± 16 Volts
Maximum current:	15 mA

RS422 Digital In

Number of channels	6 differential inputs
Isolation	Optical isolator
Detection threshold	± 0.2 V (for ± 7 V range) ± 0.5 V (for ± 15 V range)
Input current	± 3 mA
Voltage range	5 to 15 Vdc
Delay Low-to-High	65 ns

RS422 Digital Out

Number of channels	6 differential outputs
Isolation	Galvanic isolator
High level (With load) Low level (With load)	2.5 V min @ -20 mA 0.5 V max @ 20 mA
Voltage range	5 to 15 Vdc
Delay Low-to-High	55 ns

LIMITED WARRANTY

Limited Warranty

OPAL-RT Technologies Inc. warrants to the original purchaser and/or ultimate customer (“Purchaser”) of OPAL-RT products (“Product”) that if any part thereof proves to be defective in material or workmanship within one (1) year, such defective part will be repaired or replaced, free of charge, at OPAL-RT Technologies’ discretion, if shipped prepaid to OPAL-RT Technologies Inc. at 1751 Richardson, suite 2525, Montreal, Quebec, Canada, H3K 3G6, in a package equal to or in the original container. The Product will be returned freight prepaid and repaired or replaced if it is determined by OPAL-RT Technologies Inc. that the part failed due to defective materials or workmanship. Otherwise, the fees will be charged to the client (see article “Warranty Limitation and Exclusion”). The repair or replacement of any such defective part shall be OPAL-RT Technologies’ sole and exclusive responsibility and liability under this limited warranty.

Purchaser must request an RMA number before shipping any Product for repair:

1. Access the OPAL-RT website (www.opal-rt.com/support/ return-merchandise-authorization-rma-request), click on support and select Return Merchandise (RMA).
2. Fill out the online form and submit.
3. OPAL-RT’s Support department will evalute the return and either issue an RMA number via email
   - If the Product is returned for repair more than 12 months after purchase, the Purchaser is responsible for the cost of repair. OPAL-RT will assess the repair and prepare a quote. The RMA number will be sent with the quote.
4. Only when the Purchaser receives the RMA number, may they ship the Product, prepaid, to OPAL-RT.

Return Policy

the following fees will apply when customers return products for credit:

A full credit, less a 15% fee and less return fee will only be issued if the product is in perfect working condition and if the product is returned within 1 month following the shipping date. If repairs are required on the returned product, the cost of these repairs will be deducted from the credit to be issued.

No credits will be issued beyond the one month period.

Exclusions

If third party products are part of the Product, OPAL-RT will honor the original manufacturer’s warranty.

This limited warranty does not cover consumable items, such as batteries, or items subject to wear or periodic replacement, including lamps, fuses or filter elements.

Warranty Limitation and Exclusion

OPAL-RT Technologies will have no further obligation under this limited warranty. All warranty obligations of OPAL-RT Technologies are void if the Product has been subject to abuse, misuse, negligence, or accident or if the Purchaser fails to perform any of the duties set forth in this limited warranty or if the Product has not been operated in accordance with instructions, or if the Product serial number has been removed or altered.

Disclaimer of Unstated Warranties

The warranty printed above is the only warranty applicable to this purchase. All other warranties, express or implied, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose are hereby disclaimed.

Limitation of Liability

It is understood and agreed that OPAL-RT Technologies' liability, whether in contract, in tort, under any warranty, in negligence or otherwise shall not exceed the amount of the purchase price paid by the purchaser for the product and under no circumstances shall OPAL-RT Technologies be liable for special, indirect, or consequential damages. The price stated for the product is a consideration limiting OPAL-RT Technologies' liability. No action, regardless of form, arising out of the transactions under this warranty may be brought by the purchaser more than one year after the cause of actions has occurred.

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This publication is not intended to form the basis of a contract.

UM15-18121_RVN 1.0
07/2015
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